AIR WAR COLLEGE

AIR UNIVERSITY

THE 65-MILE SEAM

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153-38-8358

A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

Maxwell AFB, Alabama

February 2002

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
00 FEB 2002	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The 65-Mile Seam	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air War College; Air University Maxwell Air Force Base, Alabama**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**39**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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Chapter 1

Introduction

History is full of examples of missed opportunities from military leaders of otherwise successful nations who tried to incorporate technological advances into an outdated doctrinal framework. Technological advances should create changes in the knowledge base of decision-makers, since it modifies what is "known." But people tend to view new information in terms of an already established mental model, even to the point of disregarding the new information entirely if it does not fit their preconceived notions. While this "information order bias" is a well documented part of human nature[1], it can often lead to development of faulty doctrine which, in turn, can even result in national disaster.

The fall of France in 1940 is perhaps the most dramatic example of a country building a doctrine around a faulty premise. France emerged from World War I victorious and a world superpower. In 1936, the French military leadership addressed significant emerging technological developments in their official Army regulation, Provisional Instructions.[2] The French industrial complex could manufacture state-of-the-art military equipment of any type, however, the problem lay in the French leaders' lack of understanding in how these emerging technologies would fundamentally alter the nature of warfare.

It would be a mistake to attribute the rapid defeat of the French army to inferior technology. The fact is, France was technologically superior in many ways. For example, they not only had tanks, but they had bigger, more powerful tanks than their German adversaries—and lots of them. The French Char B tank was probably one of the best tanks in the world in terms of firepower and armor thickness. However, the Char B was tactically inferior, even if it

was not technologically inferior. The French clearly intended it to be armored artillery parceled out piecemeal to support the infantry. In doing so, they planned on set-piece slugging matches that did not require rapid mobility. The most striking evidence of this philosophy was the open engine grille on the left side of the tank, which allowed even smaller caliber German guns easy immobilization shots from the left flank. In addition, the Char B was slower, it was nearly impossible to fire outside of its forward arc, and it lacked a radio. In short, it was totally unsuited to the highly mobile warfare of the German *blitzkrieg*. [3] Again, the problem was not with the level of technological sophistication, but with their choice in how to apply that technology. The French developed inferior weapon systems because the original doctrine that drove the development was fundamentally flawed.

The military leadership of France clearly considered armor "like artillery, only mobile," suitable for supporting fires, but not a maneuver element in its own right. In contrast, the Germans, considered it a new type of combat arm--capable of not only enhancing traditional operations, but conducting independent operations as well. The result is the Germans were able to envision and implement new applications, which produced decisive effects on the battlefield. They were able to see past the new technological development as merely an extension of the existing concepts.

Like post-World War I France the United States is a victorious superpower with a dominant economy and superior technology. However these strengths do not guarantee national security, just as they did not for France. As we proceed with the military transformation from Industrial Age warfare to Information Age warfare we need to question the underlying assumptions of our doctrine to ensure we do not build on a faulty premise. One of these assumptions is the view that air and space are parts of the same medium.

The idea of the air and space environments being part of the same "seamless continuum" pervades Air Force thinking about the nature of space operations.[4] According to doctrine the "aerospace medium"[5] is an indivisible whole where the military activities the U.S. can perform in this environment are essentially the same whether or not the platform is based in air or in space. Airpower theorist Alexander de Seversky, as quoted in Air Force doctrine, said "The air ocean and its endless outer space extension are one and the same…"[6]

According to the Air Force's most fundamental expressions of doctrinal thought, Air Force Doctrine Document 1 (AFDD 1) *Basic Aerospace Doctrine of the United States Air Force* and AFDD 2 (*Organization and Employment of Aerospace Forces*), the characteristic advantages of operations in the air are identical to the advantages of operations in space.[7,8] The logical extension of Air Force doctrine implies the lessons learned from a century of airpower experience are directly applicable to operations in space, without modification. A new, and vastly improved, version of *Space Operations Doctrine* (AFDD 2-2) was published on 27 Nov 01. Written almost entirely by space operations experts, this document opens the door for innovative consideration of the potentially unique contributions from operations in space. However, this otherwise forward-thinking document still begins Chapter One with the assertion "There is no division…between air and space. Air and space are an indivisible field of operations."[9]

Airpower theoretician Dennis Drew reviewed Air Force doctrine on the subject of air and space power and concluded: "Conceptually, space power would seem to be more of the same [airpower] at a higher elevation…"[10] This paper challenges the validity of this foundational assumption and explores the implications of recognition of space as an independent medium.

CHAPTER 1 NOTES

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Chapter 2

The Space Medium

The Air Force position on the existence of a single air/space medium is based on two lines of reasoning. The first is a physical argument: "Since the early days of the space age, the Air Force has held the doctrinal view that air and space are an indivisible environment, a continuum which has no natural boundaries."[11] The second is a functional argument: "The same basic military activities can be performed in each, albeit with different platforms and methods. Therefore, space operations are an integral part of aerospace power."[12]

Air Force doctrine is out-of-step with national policy, which has already identified space as "a medium like the land, sea, and air within which military activities will be conducted to achieve U.S. national security objectives."[13] The new Secretary of Defense's (SECDEF's) views on the subject can be found in his words in the final report of the Commission to Assess United States National Security Space Management and Organization:

> "Space is not simply a place…It is a medium much the same as air, land, or seas. In the coming period, the U.S. will conduct operations to, from, in and through space in support of national interests both on earth and in space."[14]

The Commission's statement represents the notion that national interests may even exist in space independently of terrestrial interests and goes on to state the importance of space superiority, not only to defend our assets, but also to negate the hostile use of space against U.S. interests.

Although not yet codified, the current (draft) version of Joint Pub 3-14, *Space Operations*, makes the same point emphatically.

"Space forces can no longer be viewed as simply an extension of air,

land and sea forces. Instead, space must be viewed as a fourth operating medium and a region where space forces operate."[15]

The first argument--citing the inherent indivisibility of the medium--is demonstrably in error. Air operations have an upper limit of 28 miles. Beyond this, there is insufficient air to support even ramjet engines . However, the lowest useful orbit for space vehicles does not occur until about 93 miles above the surface of the Earth. Satellites in orbits lower than this altitude decay rapidly, due to the effects of interaction with very sparse air molecules.[16] Therefore, while there may not be a sharp and distinct physical boundary between the two environments, there is a vast "no man's land"--a 65-mile wide seam--separating the two in to clearly distinct parts.

A medium is defined as "an intervening substance through which something is transmitted or carried on, or as an agency for transmitting energy."[17] The intervening substance which defines the land medium is solid ground, while the vast liquid ocean defines the sea medium. The air medium consists of a mixture of gases, primarily nitrogen, oxygen and carbon dioxide. However, Space is defined and distinguished as being almost completely without substance. The correct term for this lack of substance is "vacuum" which comes from the Latin *vacuus*--literally translated as "empty."[18]

Because of the lack of atmosphere, the principle of aerodynamic lift—which makes flight possible--no longer applies in space. Spacecraft do not fly, but rather—like Buzz Lightyear in Toy Story—they "fall with style." The lack of atmosphere exposes both people and equipment to harsh radiation of virtually every type, requiring special materials, operational tactics, training and procedures. In fact the lack of an atmosphere presents a formidable challenge to space operations. The lack of air renders space an extremely hostile place. A NASA astronaut on a routine shuttle resupply mission faces a far greater risk than a USAF pilot on a combat mission in hostile territory.

Consequently drag is relatively insignificant at even the lowest orbital altitudes. This permits keeping an object in orbit comparatively easy. Satellites aren't tied to tankers or transports and don't need refueling or resupply.[20] Space assets are extremely expensive to design, build and launch. But, when the high cost of design, production and launch is amortized over the number of hours of operation--usually continuous for years after launch and checkout--the cost per operational hour is quite economical.

The atmosphere can also effect weapons systems in more subtle ways. For example, directed energy weapons based in space benefit from the "shower curtain effect." The analogy is that a person in a shower standing next to a translucent shower curtain can not see out. However an observer from the outside can easily see in to the shower. Directed energy weapons fired from space to ground experience far less distortion and loss than those fired from the air to ground or air to space.[21] In space, the losses due to interference are near zero, and the only limiting factor is that power decreases as the target gets further away. If high power is not a requirement for a particular application (i.e. covert communications), directed energy systems in space essentially have an unlimited range. The Air Force has successfully hit a target with a laser at a distance of 3.7 million miles—more than sufficient for any Earth-bound application.[22]

As a result of this physical difference in the two media, the advantages and disadvantages of operations in each vary significantly. These different advantages and disadvantages in turn imply military applications in space may not be a one-to-one extension of tried-and-true applications demonstrated in the air medium.

The dramatic differences between the physical nature of the two environments forces the Air Force into the position of trying to defend "indivisibility" on the basis of the physical presence of a very low density of atmosphere that diminishes, but does not reach zero, as altitude

increases. The Air Force correctly points out air molecules exist even at orbital altitudes. However, they exist at a density a trillion times smaller than the operating environment of aircraft. In fact half of all air molecules are found within just three miles of the Earth's surface.[19] If Air Force logic were applied to air-land or air-sea, one could argue those media are also indivisible since there are also dust particles and water droplets in the atmosphere.

It is more useful to discuss whether or not the nature of the "air" substance is significantly different from the nature of the vacuum of space. The impact of the physical differences on potential military applications is the issue, and not the physical differences themselves, whether or not it is easy to draw a boundary line on the map.

The physical differences already discussed directly lead to functional differences which affect how the Air Force can approach operations. For example, a limiting factor concerning space operations is the sheer size of what one means when discussing "space." Even the area of space operations immediately adjacent to the Earth's atmosphere—from the 90 mile altitude of the lowest orbits to the 22,300 mile altitude of the geosynchronous orbits used primarily for communications--composes an area 6,000 time larger than the entire atmosphere of the Earth up to an altitude of 50 miles.[23] It is difficult for the human mind to comprehend numbers on this type of scale. Nonetheless, the implications for military operations across this type of volume are profound. Air superiority is only required over a relatively small volume of airspace to be militarily significant. In contrast, dominating space in the same way we dominate the air is not practical given the vast size. "Space superiority," is defined in Air Force doctrine as "degree of control necessary to employ, maneuver, and engage space forces while denying the same capability to an adversary."[24] To do this effectively may require conceptually different classes of

weapons, such as directed energy weapons, which can capitalize on the lack of an interfering atmosphere and unlimited line-of-sight.

Alternatively, space superiority may involve denial of selected parts of the electromagnetic spectrum, rather than physical destruction of adversary assets. Electromagnetic signals below a certain frequency are absorbed by the Earth's atmosphere. Above a certain frequency, signals from space are reflected by the atmosphere. Therefore, only a relatively narrow range—between 300 MHz and 300 GHz—is useful for space operations.[25] Space superiority might be more analogous to sea superiority than air superiority, since naval forces need only control certain ports and straits to control the medium. Space forces may only have to control this relatively small subset of the electromagnetic spectrum to be effective.

Geographic separation is only one of many distinctions one can draw between the air and space media. For example, international law treats operations in the two media very differently. Space is defined as international territory with free access to all. Certain military activities are restricted, such as the placement of weapons of mass destruction in space. However, no nation owns the space over its territory, so there are no overflight restrictions and even offensive weapons can be pre-deployed into striking range of the deepest targets. The legal treatment of space is much more analogous to the sea than to air, and some of the oft-cited advantages of sea power may translate to space as well.

Although the lack of atmosphere is the most obvious physical difference affecting operations in the space medium, other important physical distinctions have implications for full military exploitation. For example, space really does represent the "high ground." In 1994, Gen Merrill McPeak, then Chief of Staff of the Air Force, wrote a thoughtful essay on why airmen viewed modern warfare differently than surface-bound servicemen. He concluded the unique

perspective of seeing the world from 40,000 feet was the root cause in the reason for doctrinal disputes among the services.[26] If a seven-mile difference in perspective had such a dramatic impact on the way the Air Force viewed warfare, what significant insights can be gained with a 22,300-mile difference in perspective? If the view from 40,000 feet led the Air Force to a "theater perspective" versus a tactical orientation, then the view from space leads to another shift in thinking. A space view is necessarily global. Some individual space assets can even see an entire hemisphere at once.

The Air Force concept of an indivisible "aerospace medium" is logically flawed because the actual physical and functional distinctions between air and space are as significant as the distinctions between any other two media. While it is possible to cite examples of operations that might briefly involve both the air and space media (i.e. ICBMs), this does not prove they are indivisible or functionally identical. For example, an artillery barrage briefly transits the air medium, but certainly is not considered a form of "airpower." Similarly, a battleship can fire from the sea to a target on land, but this is still "seapower" and an example of exploitation of the sea medium for military purposes. Operations in space must be fully integrated with operations in the air, land, or sea for optimal effect. However, the unique physical and functional characteristics of the space environment are sufficiently different from the air medium as to warrant consideration of it as a distinct medium. These physical differences directly impact the type of military operations the Air Force can perform in the medium as well as how even traditional operations can be executed. Therefore—for all practical purposes, there is a clear division between the two operating environments.

Chapter 2 Notes

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Chapter 3

Implications

If the Air Force were to accept space as a distinct medium, what difference would it make? First and foremost, this paradigm shift would encourage thinking not only of new ways of doing traditional Air Force missions, but also consideration of entirely new missions. For example, placing directed energy weapons in space may yield "persistent presence," allowing senior leadership a counter force option anywhere in the world with an instant response time and no need for deployment. The physical differences between the media produce a different set of advantages and disadvantages. Exploitation of the unique characteristics inherent in the space medium will lead to additional options for our senior leadership and ultimately enhance national security.

The first step in the full exploitation of any medium is developing a capability to preserve one's access to the medium, while denying its use to adversaries. This was Mahan's thesis in *The Influence of Sea Power upon History, 1660-1783* and Douhet's in *Il Domino dell'Aria*. The concept of "space superiority," although sometimes called by different names, has been a part of Air Force doctrine for several decades, but is not treated the same as air superiority in terms of either the approach or the priority assigned the mission.

Offensive Counterspace (OCS). The Air Force approach to denying adversaries access to space has been primarily through diplomacy or the destruction of ground segment of space systems.[27] This doctrine was successful in the Gulf War, since Iraq's access to space was primarily through large fixed ground stations or through services leased from Coalition

members. Iraq's few indigenous stations were highly susceptible to conventional air attacks and were taken out in the early days of the war.

However, in 1999 the Air Force attempted to counter Serbia's space access entirely through surface-to-surface and air-to-surface attacks in the Kosovo conflict, but this time the approach failed completely. The military effect of this failure was significant because, unlike Iraq, Serbia made extensive use of space—especially to disseminate propaganda. Even before hostilities began, North Atlantic Treaty Organization's (NATO's) leaders publicly discussed the need to counter Milosevic's propoganda apparatus. Milosevic's ability to spin the conflict through daily television broadcasts was instrumental in his retaining popular support and extended his ability to hold out against NATO's airstrikes. [28]

The central production facility for these propaganda broadcasts was the Serb Radio and Television station in downtown Belgrade. The video was then disseminated through a series of microwave relay towers and satellite links to individual homes, both in Serbia and the rest of the world. Although this production facility was submitted as a high priority target on the very first day, it was not initially approved. The television station was off-limits due to its proximity to St Mark's Cathedral and numerous apartment complexes. The station itself was occupied by civilians around the clock, including as many as a 100 foreign journalists.

The Air Force's alternate plan involved hundreds of sorties against the terrestrial relay towers. While most of these were successfully struck, the operational effect was negligible as Serbia still had the capacity to send out the product over its leased satellite communication transponder on EUTELSAT. In his memoirs, Waging Modern War, Gen Wesley Clark describes the extraordinary effort he had to make to finally convince Washington and NATO allies that this particular target—the Serb television station--was so vital to the war effort it justified the

near certainty of civilian collateral damage. The war dragged on without apparent progress, and on April 23 Gen Clark finally received approval for an airstrike.[29]

The airstrike was well-executed and collateral damage was limited to 16 civilian deaths in the building itself. No surrounding structures were damaged in this highly precise attack. Gen Clark identifies this attack as a success and then does not further discuss the Serb television station in his book.[30] But although a tactical "success," this attack was an operational and strategic failure. The airstrike only took Serbian television off the air for about three hours in the middle of the night. Before the next dawn the television broadcast was back on the air. That day's news—in Serbia and the rest of the world—was the attack itself supported by copious amounts of footage depicting the mangled bodies of civilians. An attack designed to halt the flow of propaganda actually resulted in feeding the propaganda machine the most damaging information of the war. World opinion sided with Milosevic over the appropriateness of this target. Even today some NATO allies are on trial for war crimes concerning their participation in the airstrike.[31]

The first strike and the subsequent strikes were ineffective because the actual critical node of the Serb propaganda machine was 22,300 miles above the surface of the Earth. The terrestrial targets were all non-essential—easily repaired or re-routed. However, the critical path was through a single transponder leased from a commercial entity comprised of a consortium of European nations. When the consortium eventually decided to shut off service, Serbian television was off the air for good. Serbia surrendered a week later, although there is still no consensus on why they chose to end the conflict since their military forces were still relatively untouched. Perhaps the loss of their only method to influence domestic and international opinion played a role in that decision. While conventional air attacks were ineffective in achieving the

desired military effect, the loss of one transponder on one satellite prevented them from broadcasting again until almost three *months* later when they could finally arrange to lease another compatible Ku-band transponder.

Attacking the ground segment of a space system is not always the most effective method to achieve space superiority. This is especially true as nations move to almost exclusively leased commercial services where the only indigenous part of the network actually in the adversary nation is suitcase-size satellite terminals. Since the U.S. cannot always rely on diplomacy to achieve the desired result, situations like this may require denial or destruction of the link or space segments of the space system to produce the desired effect.

More troubling than the failure of the Air Force to achieve space superiority in the Kosovo conflict, is the official "lesson learned" it drew from the failed attempt.

> "Space superiority was assumed from the start of hostilities. In this operation space was a neutral sanctuary that both the United States and Serbia could use to their own advantage. Serbia did not threaten the United States' space capability."[32]

There are numerous errors in logic embedded in this "lesson," taken from the Air War Over Serbia (AWOS) report. The first is the *assumption* of space superiority rather than making the achievement of space superiority a critical element of deliberate planning. If space were considered a separate medium, achieving space superiority might be a specific military objective rather than embedded in the "air and space superiority" objective and it could not be so lightly dismissed.

The second logical error in the Air Force position is the statements indicating achievement of a state of a neutral sanctuary as equivalent to space superiority. Serbia's ability to freely access the medium for military purposes contradicts the very definition of space superiority. This is, at best, space parity and not superiority as the term is used in the Joint

Vision 2020 concept. Recognition of a space medium would lead to a core belief in the need to dominate the medium to deny adversaries the military advantages of operating in the medium. The Air Force would then program for the forces necessary to accomplish this core mission.

Defensive Counterspace (DCS). A third error is somewhat more subtle, but perhaps even more significant. The AWOS report credits the U.S. with space superiority because Serbia did not threaten U.S. space capabilities. While it is true Serbia did not attempt to counter U.S. space assets, it is also true the U.S. could not have done anything to stop them if they had tried. In all likelihood, the U.S. would not have been able to even identify and locate the source of the attack. If this is superiority, it is superiority by luck. Acknowledgement of space as a separate combat medium would logically lead to recognition of a need to protect operations in the medium as a top priority against assumed adversary attempts to deny access.

The recent Space Commission report blasted the DoD over its unpreparedness to respond to a potential attack on U.S. space assets.

> "The U.S. is more dependent on space than any other nation. Yet, the threat to the U.S. and its allies in and from space does not command the attention it merits from the departments and agencies of the U.S. Government charged with national security responsibilities."[33]

The 13 distinguished members of the Commission unanimously agree space conflict is a "virtual certainty" and the DoD has failed to act to prepare for this event. "We are on notice, but have not noticed."[34]

The Air Force routinely trains and exercises with an assumed space sanctuary. The few times the Air Force injected simulated adversary offensive counterspace actions into its Joint Expeditionary Forces Experiments (JEFXs), serve to illustrate the level of unpreparedness in dealing with this threat. For example, in JEFX '98 the simulated jamming of Defense Satellite Communication System (DSCS) links between the forward and rear Air Operation Centers

(AOCs) completely shut down the AOC in about five minutes. The countermeasure employed to resume operations was to order a cessation of the simulated SATCOM jamming. In JEFX '99, the simulation was allowed to run for a one hour block, but the Exercise Communications Director chose to send the AOC personnel to dinner during that block—essentially defeating the purpose of using the simulated OCS activity to determine how an AOC would mitigate the attack and continue to perform its mission.

During the course of a JEFX, simulated Red OCS activity was allowed to proceed at Nellis AFB, although not at Hurlburt AFB where the JEFX AOC was located. By allowing the simulation to proceed, even for a small subset of the overall experiment, valuable lessons were learned. For example, communications operators did not recognize the simulated jamming as an attack even when provided significant hints in intelligence reports of adversary OCS activity. They assumed an equipment malfunction and did hours of "loop-back" tests to try to isolate what they assumed was a hardware fault. Even after they finally recognized the interruption of service as a hostile act, the operators had no idea who to tell about it. They had no standard procedures to deal with even a low-tech type of OCS attack. The ostrich approach to DCS must be reversed as the threat of an asymmetric attack on U.S. space capabilities only becomes worse with time. As the Space Commission said:

> "Assuring the security of space capabilities becomes more challenging as technology proliferates and access to it by potentially hostile entities becomes easier. The loss of space systems that support military operations or collect intelligence would dramatically affect the way U.S. forces could fight, likely raising the cost in lives and property and making the outcome less sure. U.S. space systems, including the ground, communication and space segments, need to be defended to ensure their survivability."[35]

Enemy fighters did not take to the skies to challenge U.S. aircraft in Operation ENDURING FREEDOM in Afghanistan. However, this does not logically lead to a conclusion

the U.S. no longer needs fighters. Similarly, Afghanistan did not attack our space services, but this does not translate into a lack of a future threat to space services. Recognition of space as medium for combat leads to an expectation combat will occur. As Jim Oberg describes the train of logic in Space Power Theory:

> "…the recognition of the [space] medium as an emerging linchpin for the threat and application of force and the conduct of war. As such, the ability of to negate U.S. space systems offers a key to success for would-be enemies. The fear is that, as U.S. forces increasingly come to rely on space, its potential to serve as its Achilles Heel increases."[36]

Contribution to Information Dominance. The relationship between space superiority and information superiority is worthy of some discussion, since the primary purpose of today's space systems is the collection and dissemination of information. Air Force doctrinal thought on this relationship is still evolving, but the significance of the relationship is not in question, even if the terminology used to describe the relationship is less than clear.

For example, AFDD 2-5, *Information Operations*, cites information superiority, defined as "degree of dominance in the information domain which allows friendly forces the ability to collect, control, exploit, and defend information without effective opposition," as a critical subset of "air and space superiority."[37] However, AFDD 1, describes information as a separate combat medium—essentially equal to the "air and space medium."[38] Alternate schools of thought see space superiority as a subset of information warfare (since it supports a larger overall information dominance objective), or as overlapping with space superiority, but with some distinct parts.[39]

All of these different contradictory constructs are flawed in that they are trying to compare apples and oranges. Space is a geographic location defined by its physical properties. It is a medium; operations can be conducted from it, through it or in it. In contrast, information

is a *commodity*.[40] It can be bought, sold, traded or exchanged. But one can not move through a thing called information nor can one operate from a place called information. There is no physical location for an "information medium."

Petroleum was the vital commodity which fueled national power in the Industrial Age and maintaining free access to this commodity still drives U.S. foreign policy. Similarly, access to oil remains one of the most easily defended examples of a "vital national interest." Information is the vital commodity of the aptly-named Information Age. Access to information is already an economic, and perhaps military, center-of-gravity for the United States[41] and information dominance is an essential part of modern warfare anywhere along the spectrum of conflict.[42]

Information can, and is, transmitted through any of the media, but the space medium provides particular advantages. Global coverage, the constant availability of assets, and superior perspective make the medium ideal for many information applications. The chief disadvantage of space is the high cost per pound of access to the medium, which is nearly irrelevant for the massless information commodity. Even in the poorest countries clusters of satellite dishes are a commonplace sight on the most dilapidated homes. A nomadic Bedouin tribesman in Jordan even had a satellite communication transmitter attached to his tent, right next to where he tied his camel. For much of the Third World, television signals relayed through space are one of the chief, and sometimes only, sources of information for a predominately illiterate population. Therefore access to space can sometimes equal access to information and control of space directly contributes to information dominance.

Once the province of just the two superpowers during the Cold War, space-based services are now widely proliferated and are an important element of virtually any country's economic

and military infrastructure, suggesting that offensive counterspace operations are one element of any information dominance campaign.[43] A key finding of the Blue Ribbon Panel on Air Force Space in the 21st Century: "The control and exploitation of space allow us to establish information dominance over the battlefield and enhance our ability to fight on our terms."[44] Control of space activities is a necessary step in achieving information dominance objectives. The acknowledged failure of NATO forces to achieve information dominance against a relatively unsophisticated Serbia in Operation ALLIED FORCE[45], was partially due to allowing a space sanctuary to the adversary.

An issue closely related to the ability to achieve space superiority in wartime is the need to protect space-based public services across the spectrum of war and peace. While a concept of defensive counterspace (DCS) is briefly and vaguely described in Air Force doctrine,[46] this does not directly address the mission of providing security and the assurance of safe passage or operation to commercial entities providing global utilities. Some of these utilities are important to military operations, but they are absolutely vital to the U.S. and world economy. There is no corresponding Air Force mission; the closest analogy may be the U.S. Coast Guard. It has been suggested the U.S. should place responsibility for space operations in a formal United States Space Guard (USSG). The rational is that the space medium is as vital to America's economy, the U.S. standard of living, and national security as the free navigation and private access to the seas was a century ago.[47]

Absent a USSG, there is still an urgent need to protect global utilities, which Lt Gen Bruce Carlson, now Commander, 8th Air Force, defines as:

> "Civil, military, or commercial systems—some or all of which are based in space—that provide communications, environmental, position, image,

location, timing, or other vital technical services or data to global users."[48]

The impact of space services has become so well integrated into our way of life it is now taken for granted. Fishermen use space to track schools of fish, petroleum companies locate fossil fuels, farmers map out soil conditions, and package delivery companies instantly track the progress of their deliveries. Telephones, pagers, television, the stock markets, civilian aircraft, banking and everything having to do with the Internet are completely dependent on space operations.

In 1998, there was a partial failure of Galaxy IV, a commercial communication satellite. The malfunction shut down nearly every pager in the U.S. Although this was a peacetime incident, even VIP premium customers had to wait as long as three weeks to have service re-routed. In addition video feeds for cable and broadcast transmission, credit card authorization networks and corporate communication systems were all affected.[49] Oberg points out current trends indicate the U.S. national investment in space will soon exceed the investment in all of Europe. By 2020 revenues from space services may approach as much as 15% of the U.S. entire Gross Domestic Product.[50] Loss of free access to space would be a national catastrophe—even if no U.S. military space system is affected.

Lt Gen Carlson advocates we prepare to defend against what the Space Commission referred to as a potential "Space Pearl Harbor"[51] by having the USAF assume full responsibility for global satellite protection as an extension of the scope of the current space control mission. This protection would include not only attacks by adversary nations but also piracy, terrorism or any type of attack by non-state actors. He asserts, to do this correctly, will require space-based weapons capable of performing "escort" or "active protection."[52]

The current Air Force investment in DCS is less than $1M per year and the only significant action planned for the future is to place Radio Frequency (RF) and laser threat detectors on selected military satellites.[53] The Air Force focus is on protecting essential core military space services necessary to support an air campaign. However, the level of effort devoted to even this very limited scope of DCS is anemic at best and will probably remain so until there is some type of galvanizing event, such as a deliberate attack on a U.S. space asset. Such complacency is unwarranted because the reality of adversary OCS capability has already been demonstrated.

In 1966 the Russians first demonstrated a successful Kinetic Energy (KE) Anti-Satellite (ASAT) and conducted over two dozen tests on orbit. The technology is not difficult and a primitive version of this 1960s era system could probably be employed by virtually any nation that can reach low-earth orbit. This would include nations as relatively unsophisticated as North Korea. However, even non-spacefaring nations and non-state actors can and have attacked commercial space-based services. For example, in 1997 Turkey employed SATCOM jammers to deny the Kurds the ability to use SATCOM to command and control their forces.[54] In 1999, the Russian Minister of Defense bragged about doing the same against the Chechens.[55] The world has seen conflict in space even from third world countries who were not actively engaged in a military conflict, as in 1997 when Indonesia jammed the frequency of neighboring Tonga's satellite providing services to Hong Kong.[56] In fact, a wide array of Global Positioning System (GPS) and SATCOM jammers are openly sold in the world market. Anyone with a credit card and Internet access can purchase them.[57]

The protection of global utilities is not something high on a Joint Force Air Component Commander's (JFACC's) list of concerns. The U.S. wouldn't deploy an Aerospace

Expeditionary Force (AEF) to address this threat except, perhaps, as an asymmetric reprisal. Yet protecting the services derived from assets in the space medium is of vital concern to our national survival. As the executive agent for space, the Air Force must address defense of this critical part of our national infrastructure. To do this will require a combination of advances in technology, development of new space-based capabilities, changes in employment concepts, and realistic testing and training of our forces. An air-centric view, concerned only with countering attacks on Air Force space assets is a sure recipe for disaster.

Although it takes considerable effort and expense to overcome Earth's gravity and achieve orbit, once there the absence of an atmosphere is an advantage. Without the resistance of atmospheric drag, satellites can predictably continue to orbit for long periods of time with only minor adjustments needed. The primary limitation is on their own internal power supply necessary to conduct operations, and not on the need to overcome their environment. In addition, satellites have a unique vantage point in that no area of the Earth is out of sight or out of range. A properly designed constellation of satellites, such as GPS, can provide continuous coverage of the entire Earth—24 hours a day, 365 days a year.

Space forces are already pre-deployed to respond to any crisis or threat anywhere on the globe, regardless of a lack of previous warnings and indications. In DESERT STORM, ALLIED FORCE and ENDURING FREEDOM, it took the Air Force about a month to deploy the necessary forces to initiate combat. This is fast when compared to ground forces which took 6 months of preparation in the Persian Gulf and three months in Afghanistan, even with friendly nations in the region willing to provide suitable air base facilities. However, force could be applied from space in 15 minutes to an hour of a National Command Authority (NCA) decision, independent of the cooperation of other nations.[58]

Weapons in space have several advantages over their terrestrial counterparts. First, there are no line-of-sight problems associated with major terrain features like mountains, hills and valleys. Second, objects in low earth orbit already have an inherent speed of 17,500 miles per hour.[59] This is significant since the kinetic energy of the impact of any weapon is proportional to the square of the velocity. Even a very small mass will produce enormous energy when it impacts a target at this velocity. Since the weapons themselves can be small, possibly without even having to have a warhead, a single space vehicle could simultaneously strike a large number of targets with brilliant micromunitions.[60] The speed of the attack and the lack of the need to preposition forces can produce both tactical and strategic surprise.

A third advantage of applying force from space is the status of space as international territory. In this sense a space weapons carrier is more analogous to a Navy carrier group than to air expeditionary wing. However, unlike a carrier group, a full constellation of satellites will always have a space carrier on-orbit as needed and there is no need to put thousands of American lives at risk. Therefore, if it chooses, the U.S. can act unilaterally.

The potential innovative application of force from space has been a factor in numerous wargames. In some cases, their preemptive use even prevented a major war. For example, Common Aerospace Vehicles (CAVs) have been asymmetrically used in wargames to suppress an adversary's capability to perform anti-access attacks. This could impede an adversary's strategy to deny U.S. forces entry into the seas, ports and airfields necessary to base U.S. offensive operations. Space assets also possessed the ability to strike high-value targets anywhere into any adversary's territory regardless of air defenses. [61]

In conflicts short of large-scale conventional war, space force application assets may have particular value due to their instant response. For example, former President Clinton stated

he had authorized a strike against Osama bin Laden after intelligence sources placed him at a terrorist camp. However the inability to promptly respond resulted in a cruise missile attack which struck two hours after he had departed.[62] The ability to carry different classes of munitions (deep penetrators, mines, anti-armor, anti-personnel) coupled with full geographic access and instant response, provide the NCA considerable flexibility in responding to a dynamic and ambiguous future threat.

Despite the enormous potential Air Force interest in pursuit of such a space-to-ground capability has not progressed much past wargames and initial paper studies of the supporting technologies. According to Senator Bob Smith:

> "The Air Force's space budget is dedicated almost entirely to the maintenance and improvement of information systems as a means of increasing the effectiveness of existing forces here on Earth…Even the Air Force's Space Warfare Center and Space Battlelab are focused primarily on figuring out how to use space systems to put information in the cockpit in order to drop *bombs* from *aircraft* more accurately.[63]

As Sen Smith correctly points out, "This is not space warfare. It is using space to support air warfare."[64] Funding to pursue the potentially high payoff mission of warfare from space has been limited to congressionally-directed additions to the Air Force budget. However, even a small initial capability to project force from space, whether through RF, laser or kinetic means, would dramatically enhance the amount of options available to our national leadership.

Air Force doctrine mentions space force application, but only as an extension of force application from the air. The emphasis is clearly on the support to air operations. However, space force application has some unique advantages which are obvious when space is looked at as a separate medium. Taking advantage of space's differing physical and functional characteristics results in a new concept of "persistent presence." This is a fundamental shift from an expeditionary mindset and has no clear terrestrial parallel. Douhet and Mitchell recognized

that quantum leaps in speed, range and perspective afforded by air operations would change the nature of war. Aircraft represented not just a faster tank, or a longer version of artillery, but a new class of weapon capable of independent decisive action on the battlefield. The order of magnitude advantages of space offer a similar opportunity for a new class of weapons, capable of achieving decisive effects.

The most important new military applications for space-based weapons systems may be those which will emerge only after those systems are fielded. In this Space "Field of Dreams," we build it and the innovative applications will come. The evolution of GPS applications presents an interesting case study which supports this view.

GPS was conceived in the Cold War as a means for aiding strategic bombers in crossing the Arctic poles. It is one of the simplest of all space systems—little more than a beacon. Conceptually the GPS payload is just a beacon and not particularly more advanced than the beacon on the original Russian Sputnik I. During DESERT STORM, navigation across the featureless desert became a military necessity. Although far from complete, the partial GPS constellation provided a solution to this wartime requirement. Thousands of commercial grade receivers were rushed into the field enabling the surprise "Left Hook" which dramatically concluded the ground war in a way previously inconceivable.

The explosion of commercial applications which followed completion of the constellation was even more dramatic. There are now hundreds of different applications of GPS technology in fields as diverse as archaeology, mining, architecture, education, environmental monitoring, construction, banking, telecommunication, shipping and farming, to name just a few. GPS is now used to provide secure internet transactions, validate international bank transfers, adjust car

insurance rates based on actual driving habits, track white-tail deer herds, locate lost dogs, and improve crop yields.[65]

Although the adaptation of a simple navigation aid is the most dramatic example of what can be accomplished with unrestricted thinking, it is far from unique in the history of space exploitation. The Defense Support Program (DSP) evolved from warning of strategic ballistic missiles to tactical detection, location of theater missiles, direct queuing of missile defenses and then again to support to battle damage assessment of conventional airstrikes. Military communication satellites designed for passing launch codes for ICBMs now support video teleconferences, passing of real-time imagery and internet access.

Emerging commercial applications such as space tourism, production of superior pharmaceuticals, manufacture of next-generation computer chips, advances in materials manufacturing and biotechnology will create a space industry that is not "information" based to the extent of the current space applications we know today. A little further down the road, mining of the asteroids and a return to manned exploration will lead to more or less permanent residents of space, as the commercial sector continues the trend of finding ever more innovative applications.

All of this leads to a philosophical construct of space assets having intrinsic value rather than just being useful adjuncts to terrestrial operations. Air-centric doctrinal thinking is likely to miss the military implications of these non-terrestrial advances. There have been substantial improvements in space applications as noted above. But each of these advances has been haphazard, *ad hoc* innovations made during the heat of conflict and poorly integrated into terrestrial operations. The advances in the commercial sector are an example of what is in the art of the possible with a deliberate focus. The purpose of Air Force doctrine should emulate the

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Chapter 4

Conclusion

With the maturation of airpower the United States has reached a position of unquestioned military supremacy. Each of our post-Cold War military engagements is unique and yet airpower was a dominant factor much as the early airpower prophets, Douhet and Mitchell, predicted almost a century ago. They may have erred in many of their specific predictions and concepts, but they succeeded in recognizing the tremendous opportunity afforded by full exploitation of the air medium. Douhet and Mitchell correctly realized that war from the air was not merely an extension of traditional land warfare, but a new form of warfare altogether.

History has repeatedly shown "superpower" status can be fleeting and that superior technology is not a guarantee of national survival. Rather, history shows the ability of leadership to adapt to the changing conditions brought on by technological change that is the key to a nation's security. Although the United States has conducted operations in Space for more than a generation, only within the last few years have practitioners seen the proliferation of space assets and the rapid expansion of applications. In 1997 the money invested by the commercial sector exceeded the military space sector and the gap has widened substantially each year.[66] The United States military is no longer a very significant player in the ability to influence the Space industry.

The increasing military and economic significance of space operations adds a sense of urgency to the need to build a clear and logical body of doctrinal thinking on the unique aspects of operations in Space. While the Air Force continues to make progress on this issue, with each document release better than the last, innovative thinking is constrained by the issue of trying to

make a case for Space and Air being either identical or at least functionally equivalent. This is driven by a fear the Air Force will lose the space missions—either to other Services, some Defense Department agencies or even to the creation of a new Service. Ironically, it is the failure to recognize Space for what it is—a separate combat medium—that is the most serious threat to Air Force retention of these missions. It is the rhetoric about a "seamless medium" and the lack of programmatic support for any Space initiative not directly supporting air operations which provides the critics the ammunition they need to prove the Air Force just "doesn't get it."

The Air Force asserts its mission is "to defend the United States through the control and exploitation of air and space."[67] While it is the unrivalled master in the control and exploitation of the air, the Air Force has only selectively exploited space and completely ignored control of the medium. General Jumper, CSAF, has correctly placed the emphasis on "Effects-Based Operations."[68] In his concept, it doesn't matter where the platform is based, only what type of effect can be generated in support of the national military objectives. This would appear to open the door to a paradigm shift away from space systems valued only for their ability to support aircraft. As General Deptula said in his transformational work for the Quadrennial Defense Review, space-based platforms provide "…the next generation of effects-based warfare."[69]

To realize the vision described by General Deptula and General Jumper the Air Force must do more than address space in its thinking and its documents by simply replacing all references to "air" with "aerospace" or "air and space." The Air Force has responsibility for both air and space, but needs to recognize air and space as distinctly different operational media governed by profoundly different physical principles. These physical differences are not merely semantic or esoteric distinctions. They translate in to a very different set of operational advantages and disadvantages. Clearly operations within both media need to be integrated for

maximum combat synergy, but the same holds true with the need to integrate operations with the sea and ground media.

Most importantly, the recognition of a separate medium could lead to development of systems which better capitalize on the unique aspects of the medium to produce an entirely new set of effects such as negation of an adversaries space services. Not all of these effects are necessarily part of traditional Air Force capabilities. Offensive and Defensive Counterspace, Information Dominance, Persistent Presence and the Protection of Global Utilities are just the tip of the iceberg. Just as the fielding of the relatively simple GPS system spawned hundreds of diverse and revolutionary applications, the potential for military advantage is as infinite as Space itself.

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